HIE-ISOLDE Workshop: The Technical Aspects

28 - 29 November 2013

Status of RAON: New RIB Facility in Korea

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on behalf of RISP/IBS

Project History & Science Goal

RAON

- ISBB plan (2009.1)
- Preliminary Design Study (2009.3-2010.2)
- **Conceptual Design study (2010.3-2011.2) : KoRIA**
- Institute for Basic Science(IBS) established (2011.11)
- **Rare Isotope Science Project(RISP) launched (2011.12)**
- **Baseline Design Summary (2012.6) : RAON**
- **Technical Design Report (2013.9)**

- Highest priority research subjects
  - Nuclear reaction experiments important to nuclear-astrophysics : e.g. $^{15}O(\alpha,\gamma)^{19}Ne$, $^{45}V(p,\gamma)^{46}Cr$
  - Nuclear structure of n-rich RI's near 80<A<160
  - Nuclear symmetry energy at sub-saturation density
  - Precision mass measurement & laser spectroscopy
  - Search for super-heavy elements: Z>119 (Z ~120)
- Important scientific applications
  - Material science : β-NMR, μSR
  - Medical and bio-sciences
  - Nuclear data for next-generation NPP

Steps of RISP R&D

2009

LoIs from domestic users

- **Science program** with RI beams up to 200 AMeV
- **83 LoI's**
  (nuclear/astrophysics, nuclear data, standard model, biomedical, mass measurement, material science, ERD analysis)

2010 ~ 2011

Science classification

- Nuclear science
- Atomic & Molecular science
- Material science
- Medical & Bio science

2011 ~ 2013

Facility specifications

- Beam specifications
  (energy, intensity, pulse width …)
- Specifications of facilities

We are here!!!

2013 ~ 2018

R&D and Installation

- Spectrometer
- Detection system
- Beam line
- Apparatus for applied sciences

2018 ~ 2020

Day-1 experiments

Programmed Experiments

Upgrade and Extension

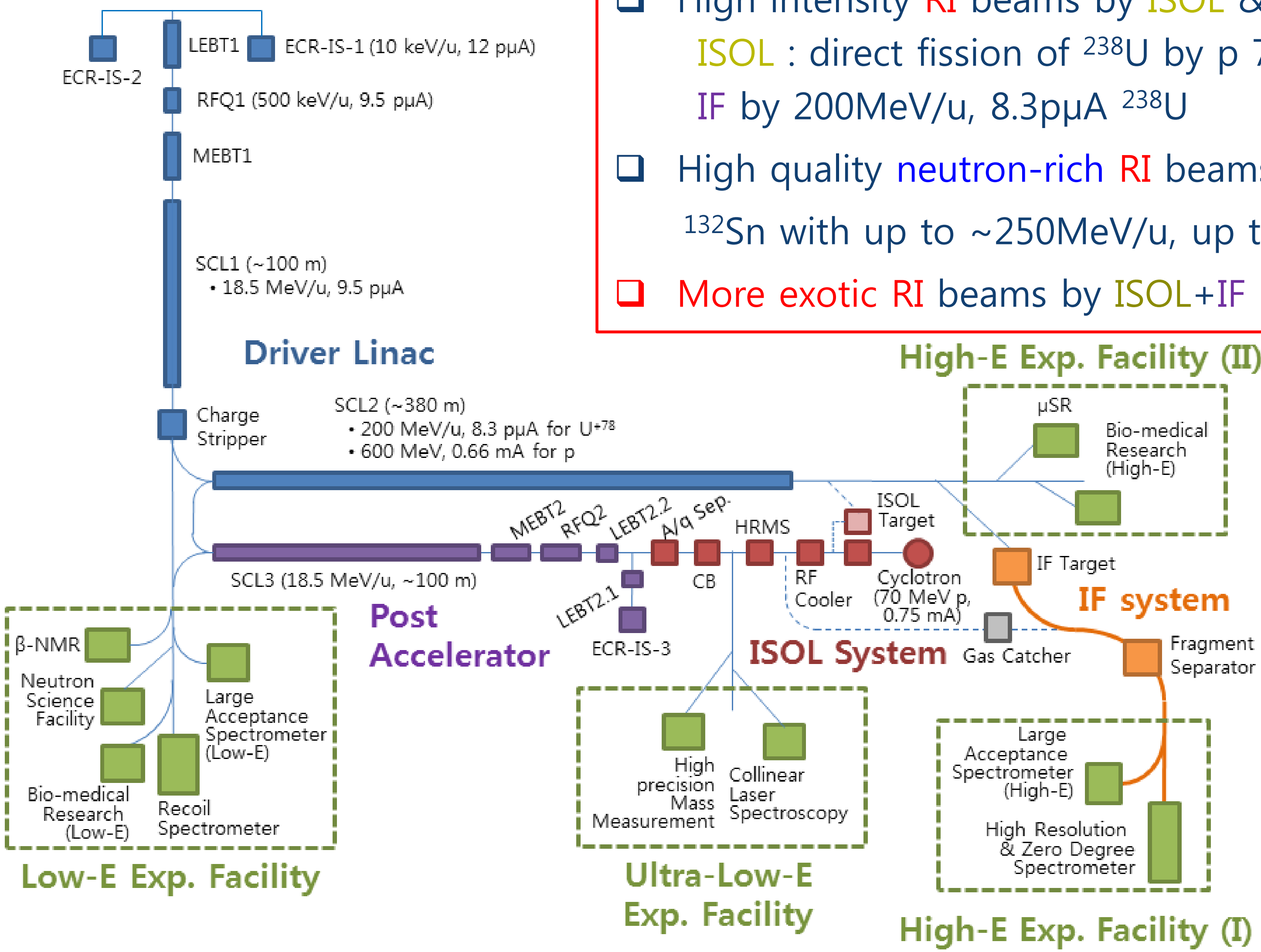
2013

Refinement

- Based on Realistic modification of specifications
- **PAC (Oct 2013)**
- **Expression of Interests (EoIs) (domestic + foreign)**

RAON : RISP Accelerator Complex

- High intensity RI beams by ISOL & IF
  - ISOL : direct fission of ^{238}U by p 70MeV
  - IF by 200MeV/u, 8.3pμA ^{238}U
- High quality neutron-rich RI beams
  - ^{132}Sn with up to ~250MeV/u, up to 10^8 pps
- More exotic RI beams by ISOL+IF



RAON Site

Jilin
Ussuriysk
Vladivostok
Fushun
Shenyang
Tong Hua
Anshan
Dalian
Pyongyang
북한
Seoul
Incheon
대한민국 강원도
Daejeon
대한민국
Qingdao
Daegu
Kwangju
Busan
Cheju do
Fukuoka
Shikoku
Yokohama
Nanjing
III지구
II 지구
V 지구
I 지구
© 2008 ZENRIN
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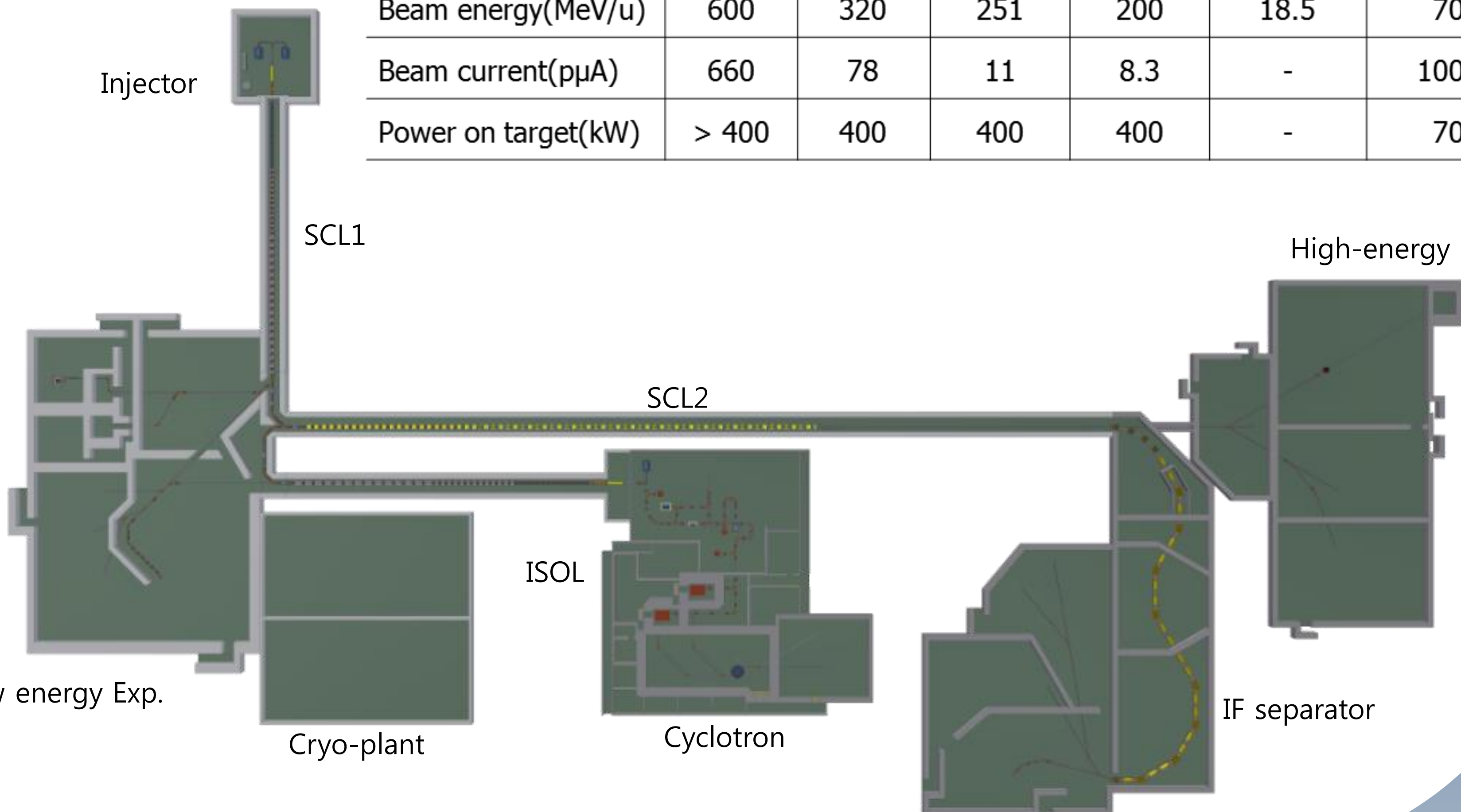
38°21'36.92" N 128°35'27.44" E
내려다보는 높이 1614.16 km

RAON Design – Accelerator & Experimental Hall

	Driver Linac				Post Acc.	Cyclotron
Particle	H^+	O^{+8}	Xe^{+54}	U^{+79}	RI beam	proton
Beam energy(MeV/u)	600	320	251	200	18.5	70
Beam current(pμA)	660	78	11	8.3	-	1000
Power on target(kW)	> 400	400	400	400	-	70



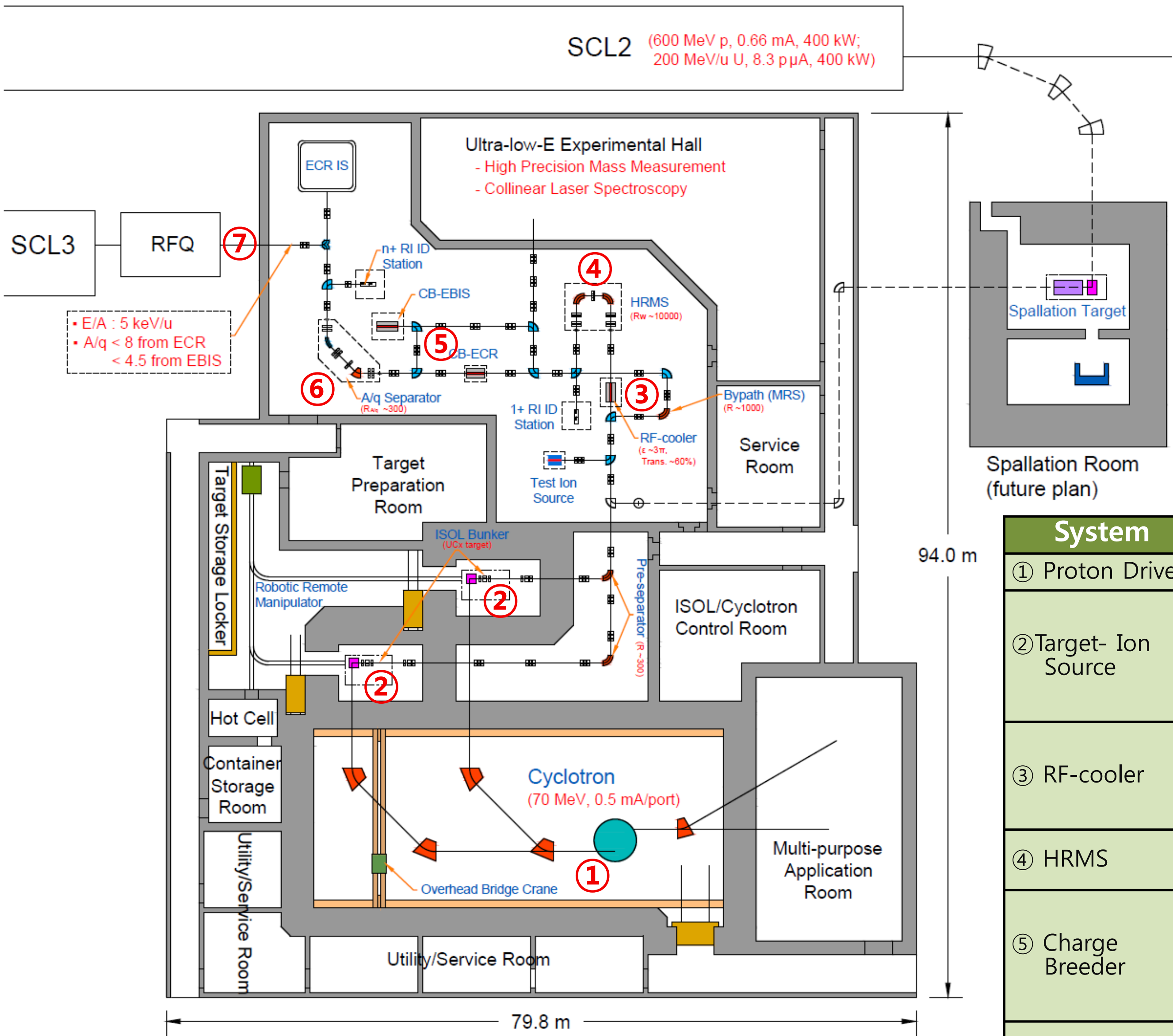
Science Program with Beam Schedule

RAON

Beam schedule	Science program	Exp. facility#	Beam species on exp. target† (Day-1)	Beam species on exp. target† (Extra 2 years)	Beam Intensity on exp. (pps) (required/expected)
2018.Q2 ~ from SCL1 (<18.5 MeV/u)	Nuclear structure SHE search, rp-process, Spin physics	RS	^{54}Cr	^{64}Ni, ^{26m}Al (^{28}Si), ^{25}Al (^{28}Si), ^{44}Ti (^{42}Ca), ^{14,15}O (^{15}N)	^{15}N, ^{54}Cr, ^{28}Si, ^{42}Ca, ^{50}Ti, ^{25}Al, ^{26m}Al, ^{44}Ti, ^{14,15}O: ($10^{5\text{-}6}$)
	Pigmy dipole resonance	LAS-L	^{58}Ni	^{40}Ca, ^{112}Sn	($10^{6\text{-}8}$ / $<10^{9\text{-}10}$)
	Biological effects	BM	^{12}C		($<10^{12}$ / $>10^{12}$)
	New materials, Polarized beam	β-NMR	^{8}Li by (d, n)(n,α) or (p,2p)		^{8}Li (10^{8} / 10^{9})
	Neutron cross section	NSF	n by (p,n) and (d,n)		n ($<10^{12}$ / 10^{12})
2019.Q4 ~ from ISOL (~5 keV/u)	Hyperfine structure, Mass measurement	Ion Trap LS	^{132}Sn	$^{130\text{-}135}$Sn	^{132}Sn ($<10^{5}$ / 10^{7})‡, $^{130\text{-}135}$Sn ($10^{3\text{-}6}$ / $10^{3\text{-}7}$)
2019.Q4 ~ ISOL-SCL3 (<18.5 MeV/u)	r-process	RS	^{132}Sn	$^{130\text{-}135}$Sn	^{132}Sn (10^{6} / 10^{7}), ^{65,66}Ni ($10^{6\text{-}8}$ / $10^{6\text{-}7}$)
	Pigmy dipole resonance	LAS-L	^{132}Sn	$^{50+n}$Ca, $^{60+n}$Ni, $^{106+n}$Sn	
2019.Q4 ~ SCL1-SCL2 (~ hundreds MeV/u)	New materials	μSR	μ^{+} by (p, πx)		μ^{+} (10^{8} / 10^{9})
	Biological effects	BM	^{12}C		($<10^{12}$ / $>10^{12}$)
	Baseline experiments, Spin physics	LAS-H	^{40}Ca	^{58}Ni, ^{112}Sn, ^{132}Xe	($10^{6\text{-}8}$ / $<10^{9\text{-}11}$)
2020.Q2 ~ SCL1-SCL2-IF (~ hundreds MeV/u)	Nuclear structure	ZDS & HRS	$^{100+n}$Sn	$^{100+n}$Sn	^{128}Sn ($10^{6\text{-}8}$ / 10^{7}), ^{132}Sn ($10^{6\text{-}8}$/10^{7})‡
	Symmetry energy	LAS-H	^{132}Sn	$^{44+n}$Ca, $^{60+n}$Ni, $^{106+n}$Sn, ^{144}Xe	
2020.Q4 ~ ISOL-SCL3-SCL2-IF(X) (~ hundreds MeV/u)	Nuclear structure	ZDS & HRS	^{132}Sn		^{132}Sn ($10^{6\text{-}8}$ / 10^{7})‡, ^{144}Xe ($10^{6\text{-}8}$ / 10^{6})
	Symmetry energy	LAS-H	$^{106+n}$Sn	$^{133+n}$Xe	
2021.Q2 ~ ISOL-SCL3-SCL2-IF (~ hundreds MeV/u)	Nuclear structure	ZDS & HRS			^{78}Ni (/ <2)

♯ **RS**: Recoil Spectrometer, **LAS**: Large Acceptance Spectrometer, **BM**: Bio & Medical, **LS**: Laser Spectrometer, **NSF**: Neutron Science Facility, **ZDS**: Zero Degree Spectrometer, **HRS**: High Resolution Spectrometer † Beam species : **SI (black), RI (Blue)** ‡ Beam purity >90 % for ISOL, 9% for IF

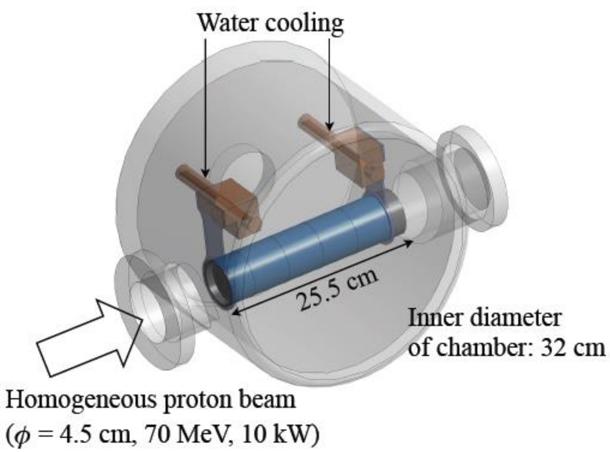
Layout of ISOL Facility



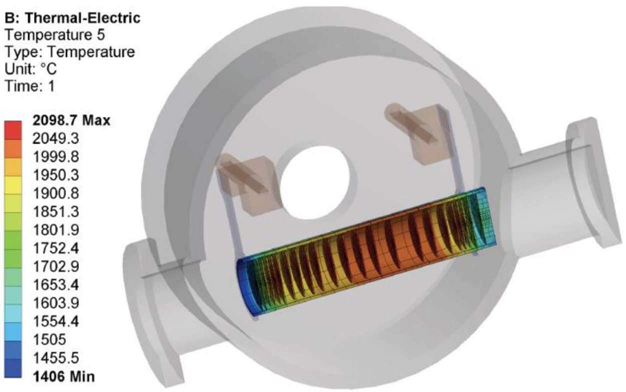
System	Development Goal
① Proton Driver	Cyclotron (70 MeV, 1 mA)
②Target- Ion Source	▪ Fission Target (10 kW & 35 kW) • 1.6×10^{13}~1.2×10^{14} f/s • 2.2×10^{9}~1.6×10^{10} ^{132}Sn/s ▪ Ion Sources • SIS, RILIS, FEBIAD
③ RF-cooler	▪ CW and Pulsed ▪ Beam current : up to 1 μA ▪ Emittance : ~ 3 π, ΔE/E < 5×10^{-5} ▪ $\varepsilon_{trans.}$> 60 % (CW)
④ HRMS	▪ R_w~10,000 ▪ D > 34 cm/%
⑤ Charge Breeder	▪ EBIS (ECR) • efficiency : 4~30% (1~18%) • A/q : 2~4 (4~8) • E spread (eV/q) : ~50 (1~10) ▪ E/A : 5 keV/u
⑥ A/q Selector	▪ $R_{A/q}$ ~300 ▪ E+B combination
⑦ Re-accel	▪ Super-conducting LINAC (0.5~18.5A MeV)

ISOL Target (10 kW UCx) Design

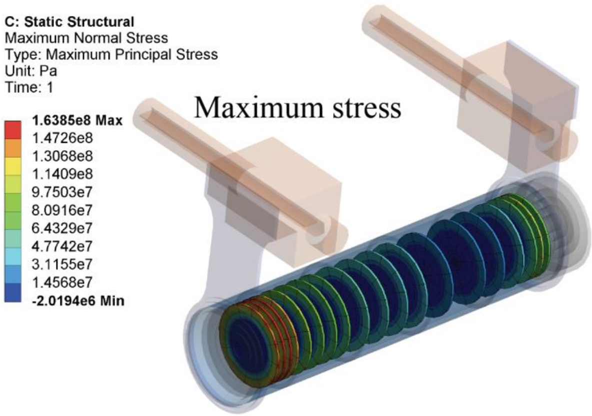
- **ISOL target optimization**
  - high fission rate & release efficiency
  - $Y_{ISOL} = \Phi_P \cdot \sigma_f \cdot N_{target} \cdot \varepsilon_{release} \cdot \varepsilon_{is} \cdot \varepsilon_{cooler} \cdot \varepsilon_{ms} \cdot \varepsilon_{CB} \cdot \varepsilon_{aq} \cdot \varepsilon_{acc}$
  - uniform high-temperature (2000~2100℃) & low thermal stress
  - solution: low-density (2.5~5 g/cm^3), porous, thin multi-disk UC_x target
    - ➢ 50 mmΦ, 1.3 mmt, 19 disks, 2.5 g/cm^3, 101 g of U (5.14 g/cm^2)

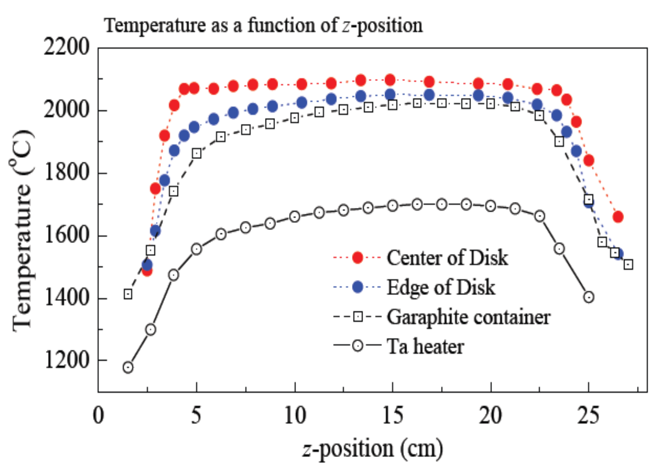


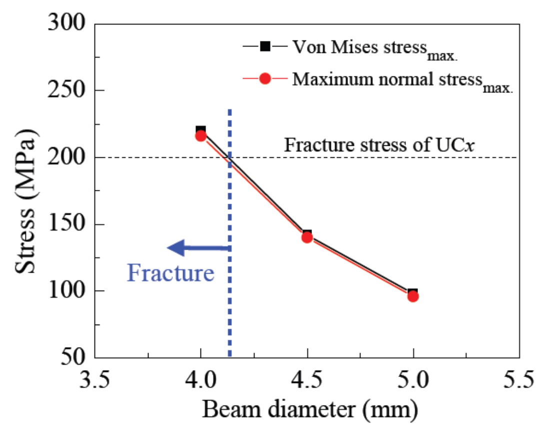
Temperature



Thermal stress



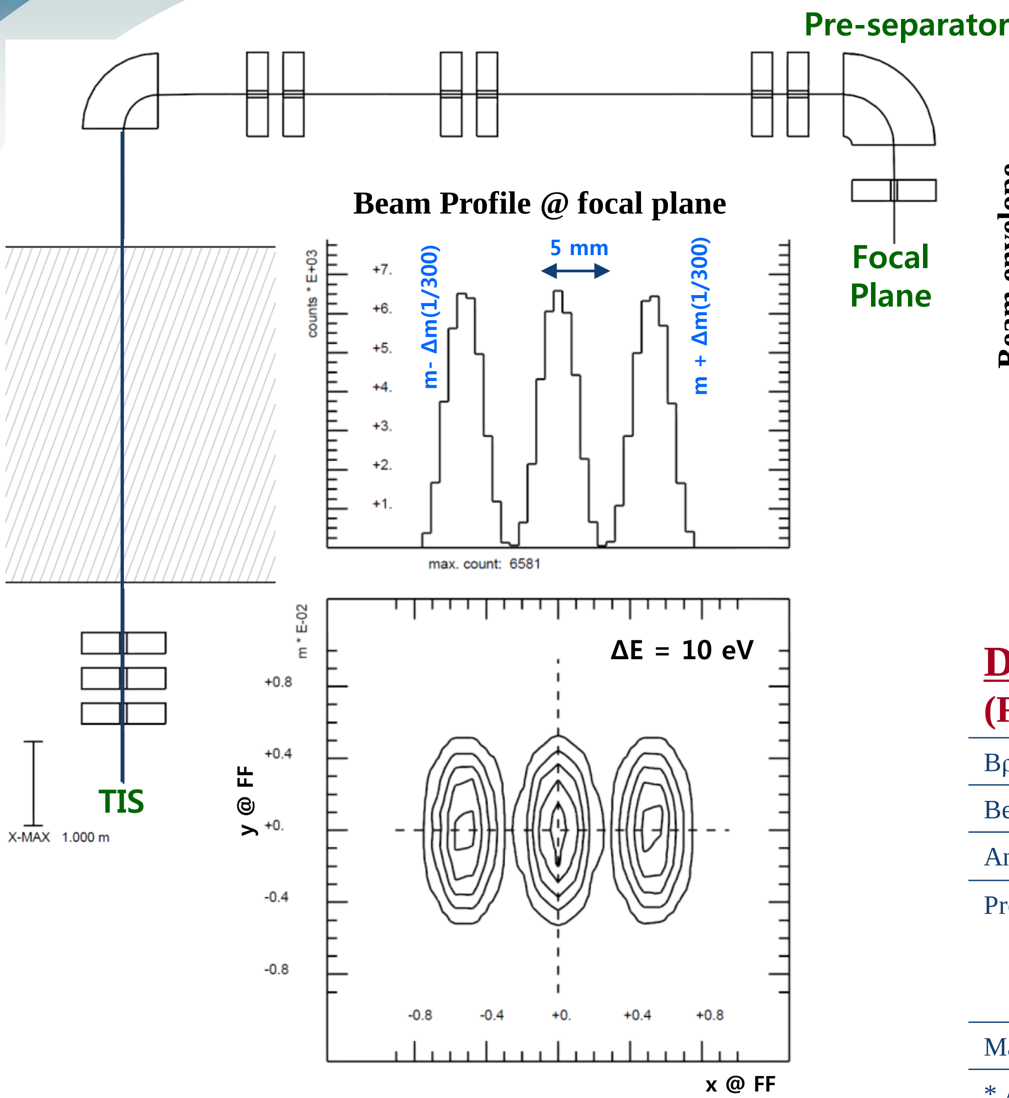


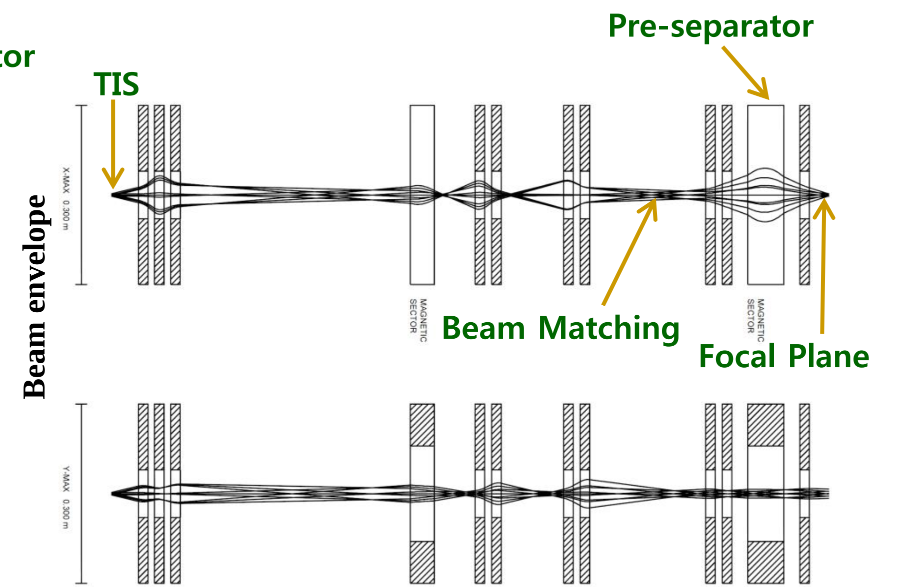


Beam size optimization

Beam size	Fission rate	Max. stress
40 mmΦ	1.63x10^{13} s^{-1}	216 Mpa
45 mmΦ	**1.58x10^{13} s^{-1}**	**142 MPa**
50 mmΦ	1.49x10^{13} s^{-1}	96 MPa

Design of Pre-separator





Design Parameter
(Ref. isotope: ^{132}Sn 35 keV, 30 π mm mrad)

Bρ		0.31 Tm
Beam size		±2 mm
Angular acceptance		±15 mrad
Pre-Separator	Bending angle	90°
	Bending radius	60 cm
	Pole face angle	26.5°
Mass Resolving power		300

* All components are electrostatic module except for dipole

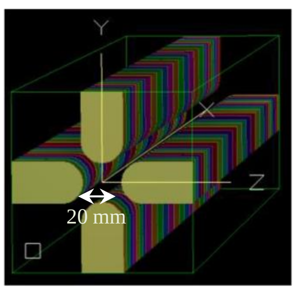
RFQ-Cooler

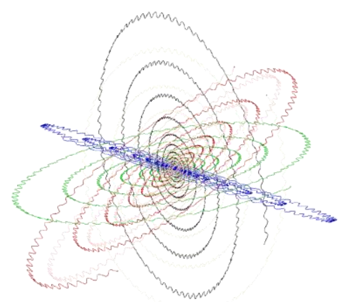
● Objectives of the device

- **Enhancement of the ion beam quality for** HRMS by reducing the energy spread and the emittance.
- **Target specifications**
  - emittance <3π mm mrad @ 20 keV
  - energy spread (ΔE/E) ≤ 5×10^{-5}
  - transmission efficiency > 60 % (DC mode)
  - acceptable beam current: up to 1 μA

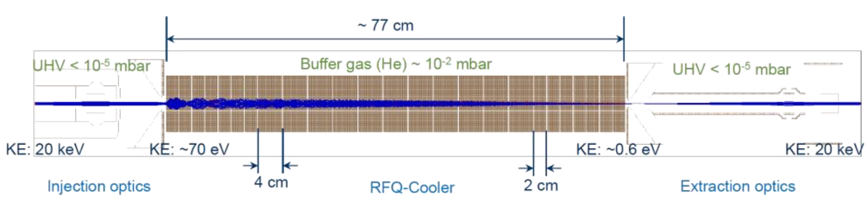
● RFQ-Cooler simulation

- Injection optics simulation for efficient injection of ions into RFQ
- Hard sphere collision model for the buffer gas cooling process inside the RFQ region
- Calculation of transmission efficiency, energy spread, emittance

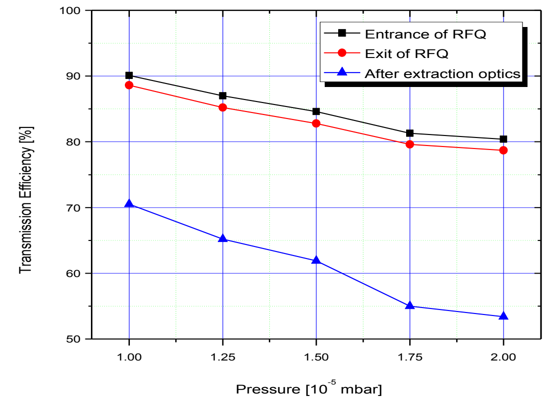




Radial trajectory in RFQ-Cooler



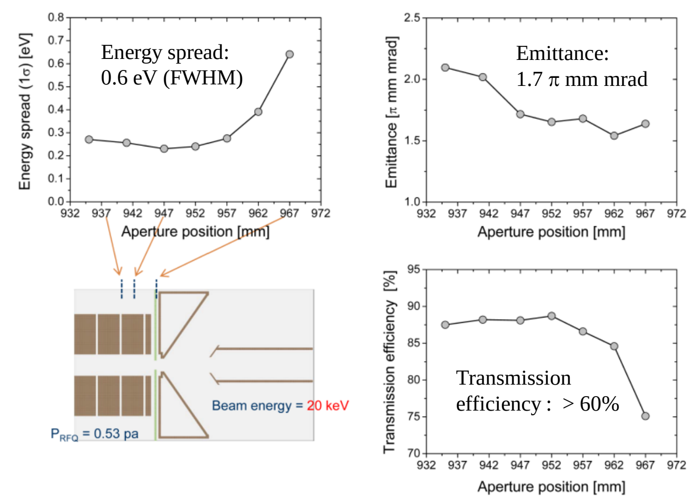
● DC mode operation



ε : 1.8 π mm mrad
ΔE : 0.6 eV (FWHM)
Transmission > 60%e

Transmission eff. with the pressure outside RFQ

● Bunch mode operation



Ion beam quality with the aperture position

HRMS (High-Resolution Mass Separator)

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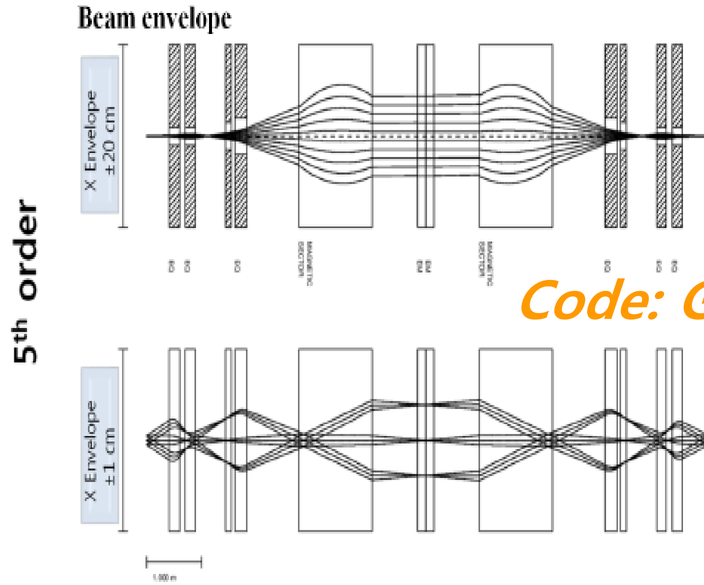
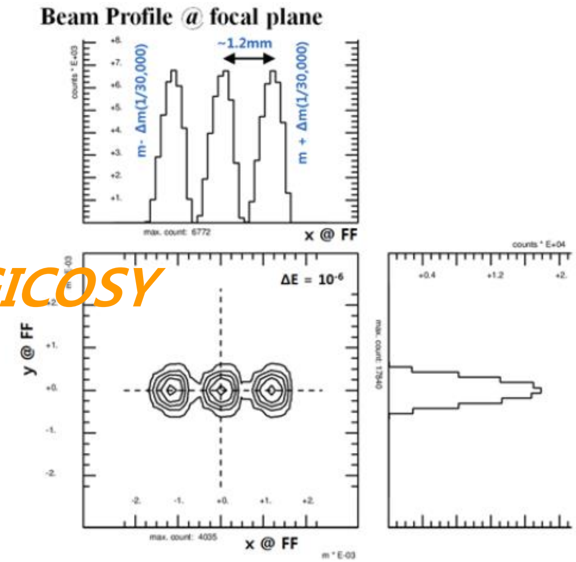
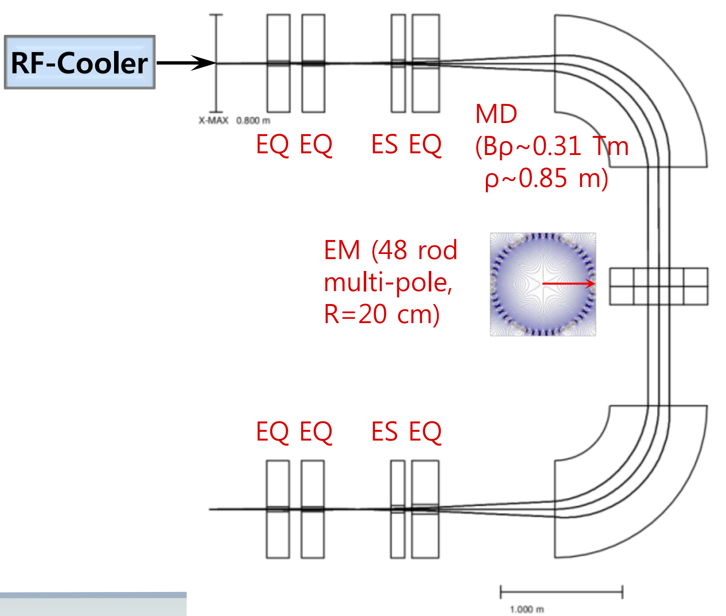
Parameters

- QQSQ-DMD-QSQQ symmetry
- KE < 50 keV ($\Delta E/E=10^{-6}$)
- acceptance : 3π mm mrad (input ~2π mm mrad)
- total length ~11 m
- dispersion D_m : 34 cm/%
- R_w> 10,000

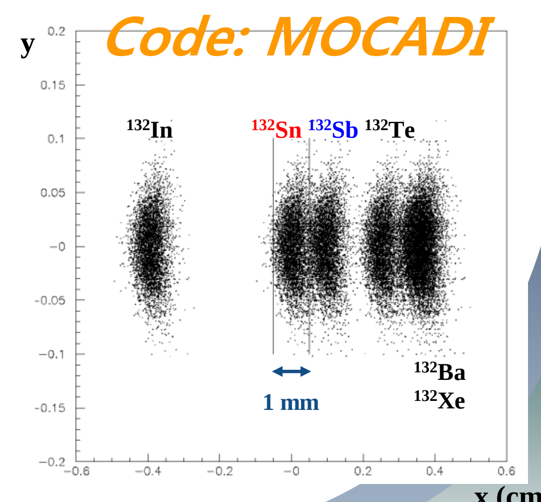




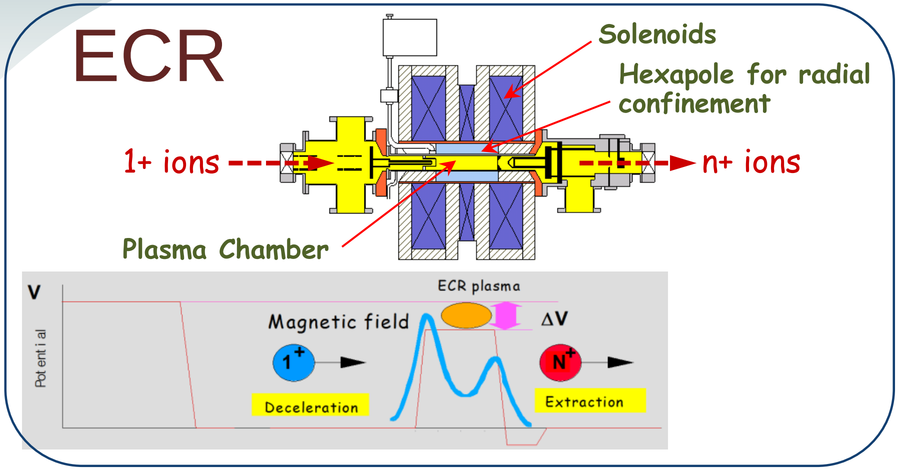


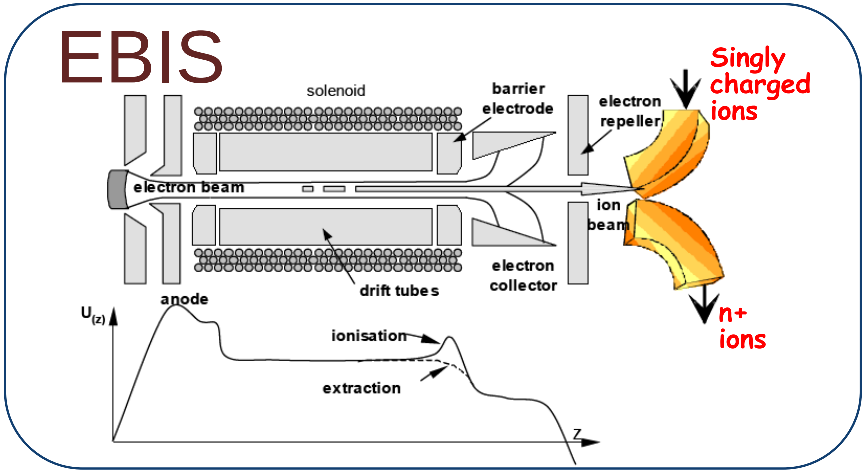
Isobar separation

- Slit width : ±0.5 mm
  - transmission ~93 % for ^{132}Sn
  - contamination of ^{132}Sb ~4 % (assuming same intensity)
- systematic instability not considered



Charge Breeder



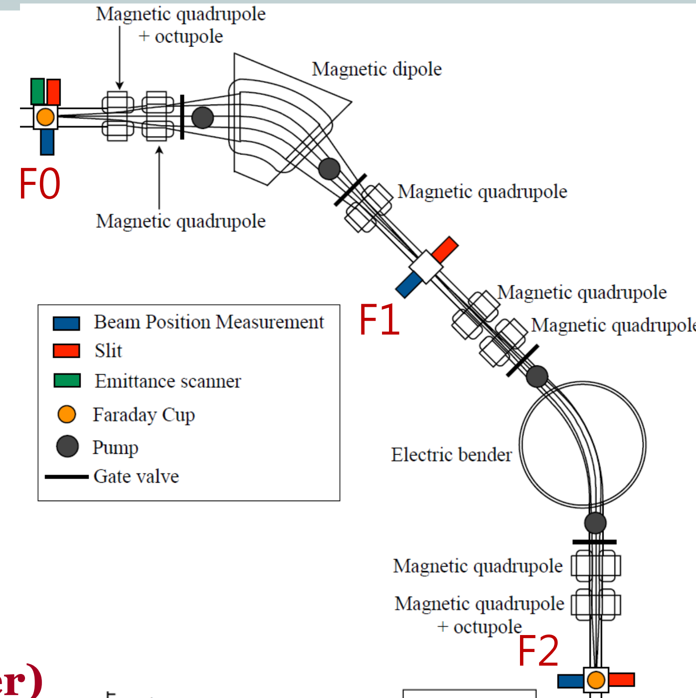


Comparison of performances of the ECR and EBIS charge breeder

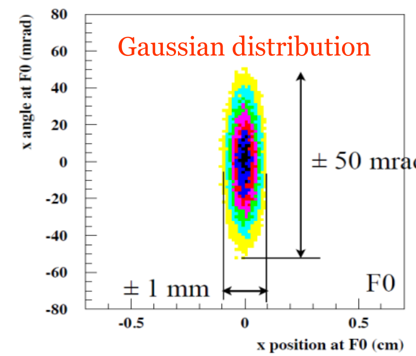
	ECR	TRAP / EBIS
Efficiency	1-18%	4-30%
Ion capacity / Low limit	high (1e12 ions/s) / 10 nA	low (1e9 ions/s) / fA
A/q	high (4-8)	low (2-4)
Acceptance / Emittance	>50 π / <80 π	3~10 π / 15~20 π
A	injection difficult for A<20	no real limitation
Breeding time	100~300 ms	13~500 ms (depending on A)
Background	support gas and rest gas in between peaks 10 pA ~ 10 nA	rest gas peaks 10~100 pA in between peaks <0.1 pA (not detectable)
Energy spread (eV/q) (1σ)	1~10 (up to 0.5%)	~50
Injection / Extraction	CW or pulsed / CW or afterglow	pulsed (a few tens μs) / pulsed (10~50 μs)
System complexity / Maintenance	simple / good	high / bad (cathode life)

A/q Separator ($R_{A/q}$ ~300)

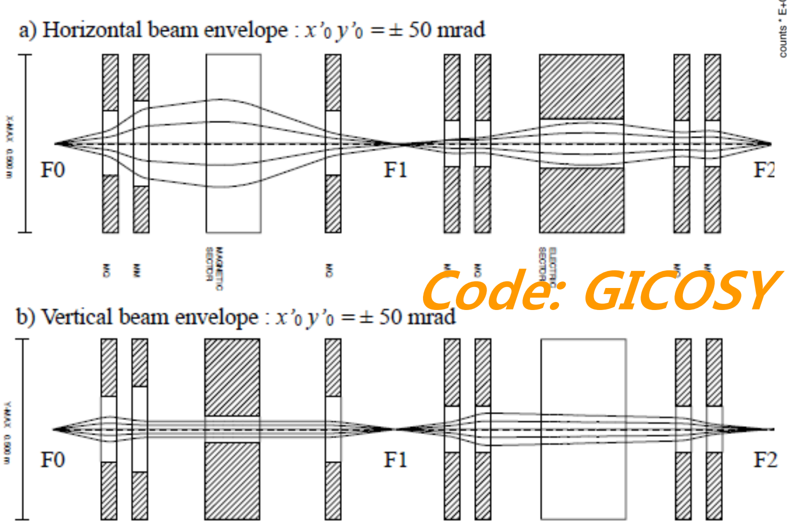
- Combine B+E, $A/q=(B\rho_B)^2/(E\rho_E)$
- Angular acceptance : ±50 mrad
- Energy acceptance : ±0.25 %
- Momentum resolving power at F1 ~930 (1st order)
- Mass resolving power at F2 ~460 (~300 for 5th order)
- Electric bender : ρ 1.4 m, gap 14 cm
- Magnetic dipole : ρ 0.9 m, gap 7 cm
- Total length (F0-F2) ~ 9.4 m
- Transmission: ~84 % for ^{132}Sn

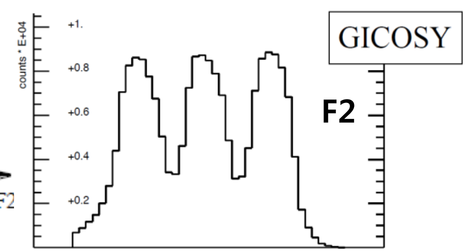


Initial Beams at F0

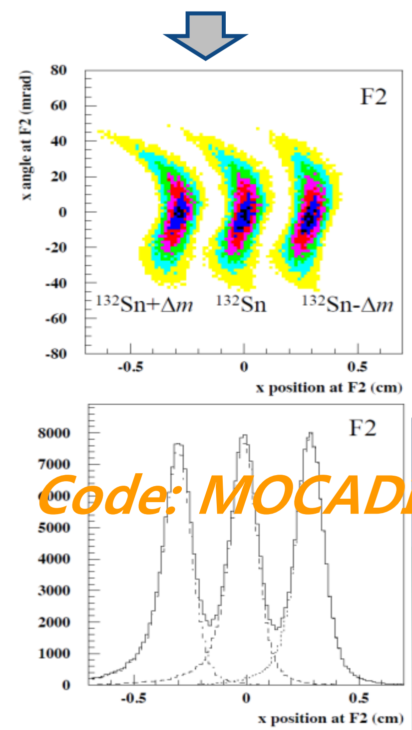


Ion optics calculation (5th order)





A/q spectra at F2

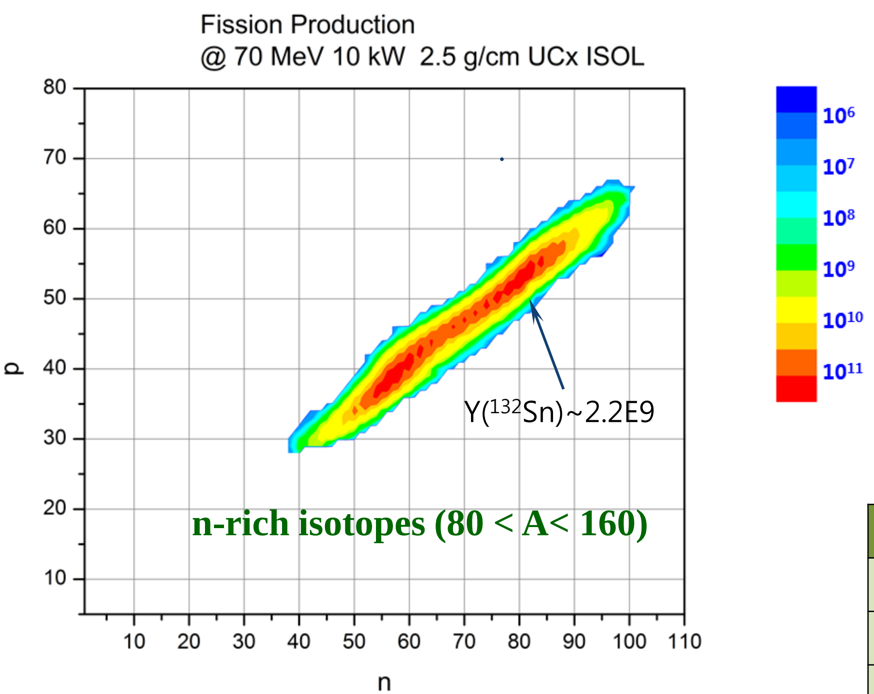


	transmission		
	^{132}Sn -Δm	^{132}Sn	^{132}Sn +Δm
F0 to F1	82.3%	95.7%	63.4%
F1 to F2	6.9%	87.8%	3.3%
F0 to F2	5.7%	**84.0%**	2.1%

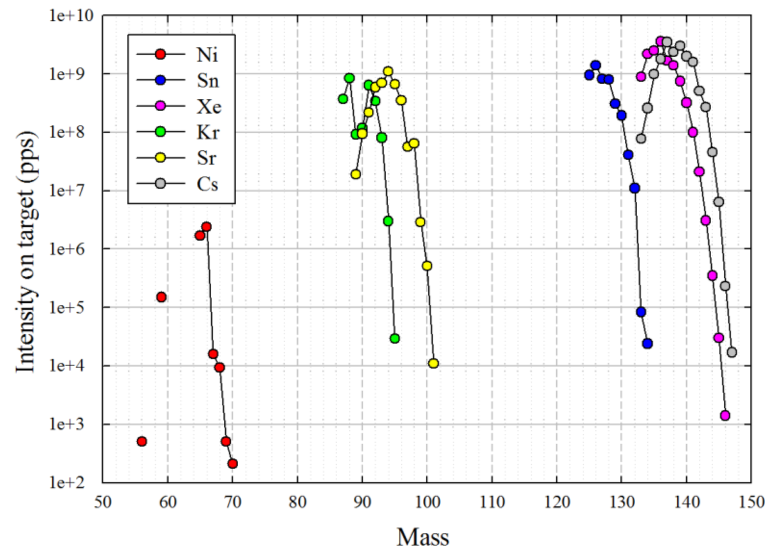
RI Yield estimation

- p + UCx → n-rich isotopes (80 < A< 160) by fission reaction
- Fission rate (10 kW) : 1.6×10^{13} f/s

Production yield (10 kW ISOL target)



Expected lab. intensities (10 kW target)



Isotope	Half-life	Science	Lab. Yield (pps)
^{66}Ni	2.28 d	pigmy	4×10^5
^{68}Ni	21 s	symmetry	5×10^6
^{132}Sn	39.7 s	r-process, pigmy	1×10^7
$^{130-135}$Sn	0.5 s ~ 3.7 min	Fine structure, precision mass	10^4~10^8
^{140}Xe	13.6 s	Symmetry	3×10^8
^{144}Xe	0.4 s	Symmetry	1×10^5

ISOL Target Preparation

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Processing route for carbide production

Materials

- La_2O_3 (99.99% powders, Sigma Aldrich)
- Graphite (<45 μm, Sigma Aldrich)

Powder & disk preparation

1. Grinding & mixing of La_2O_3 & C powders in a planetray Ball Mill
2. Addition of (1.5~2.1) wt.% of phenolic resin (dissolved in acetone) as a binder & mixing
3. Disk target (13 mmΦ, 1.3 mmt) formation by cold pressing of powers (~750 Mpa, 45~60 min)

Two-step thermal treatment

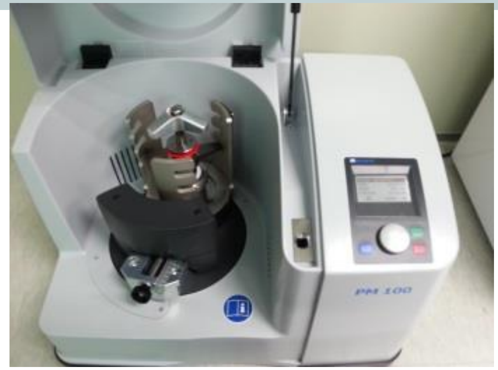
1. Promotion of the carbothermal reaction (2℃/min up to 1250℃, 24 h at 1250℃) under vacuum (10^{-7}~10^{-5} mbar)

   *** $La_2O_3 + 11C \rightarrow 2LaC_2 + 4C + 3CO$**
   *** monitoring of the reaction by RGA & vac. gauge**

2. Sintering the carburized powders (2℃/min up to 1600℃, 4 h at 1600℃)
3. Slow cooling at a rate of 2℃/min

Characterization

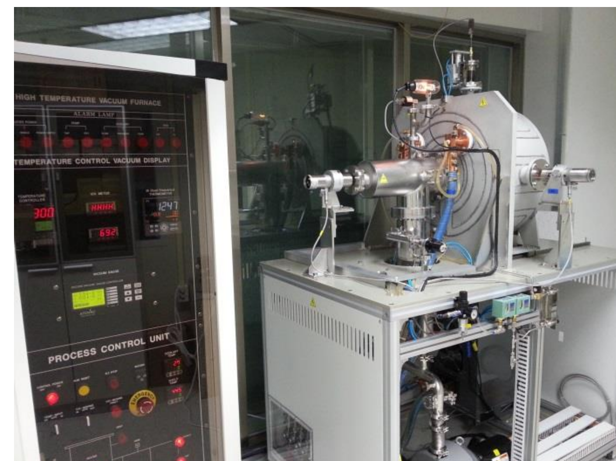
1. Grain size, density & open porosity, stoichiometry (SEM-EDX, XRD, He-pycnometer)
2. (high-temperature) emissivity & conductivity (dual-frequency pyrometer)



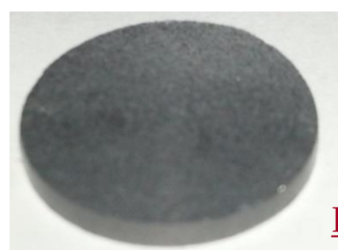
Planetary Ball Mill

Glove Box

210 ton Press

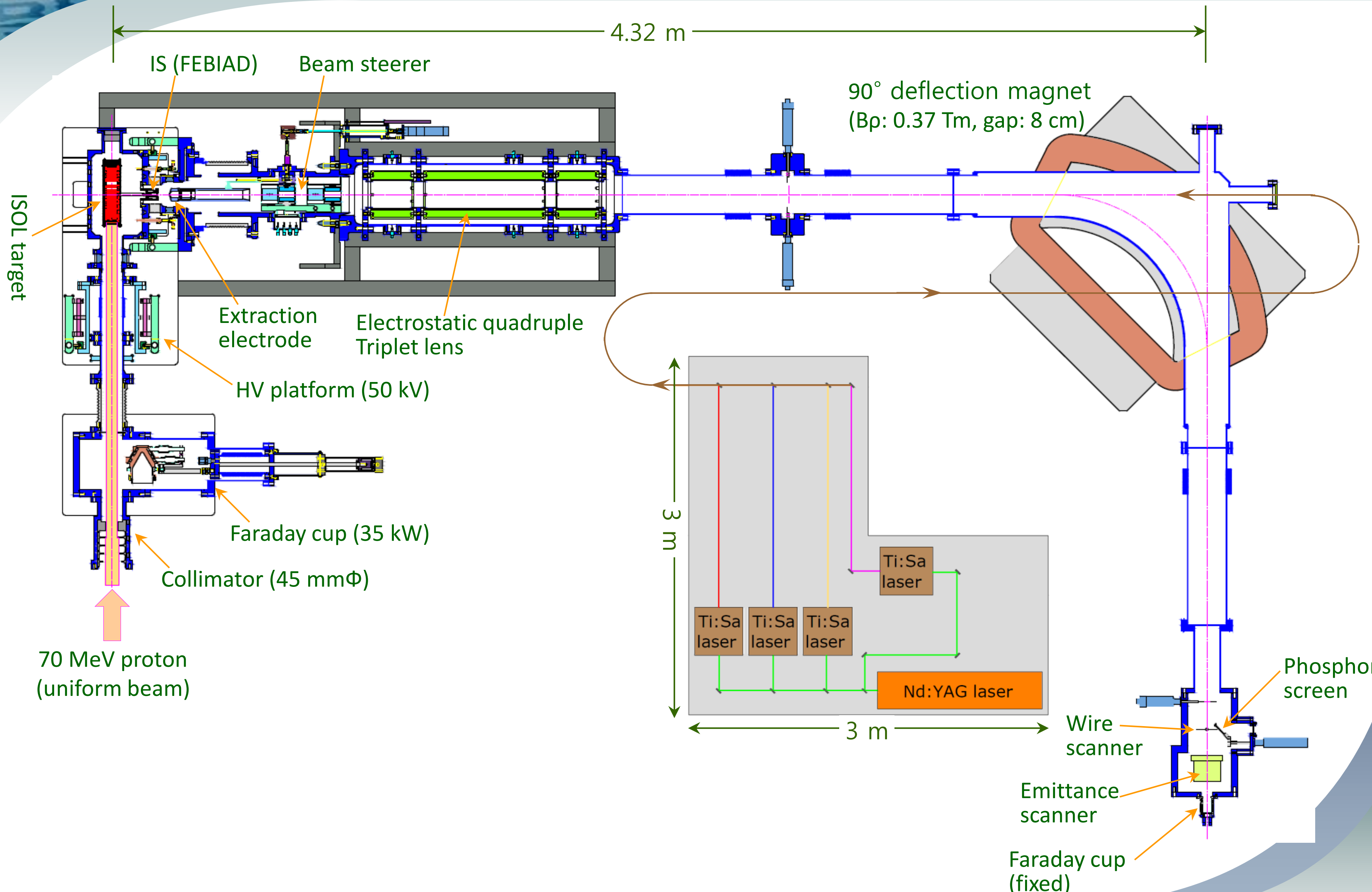


High-temp. (2100℃) high-vacuum Furnace



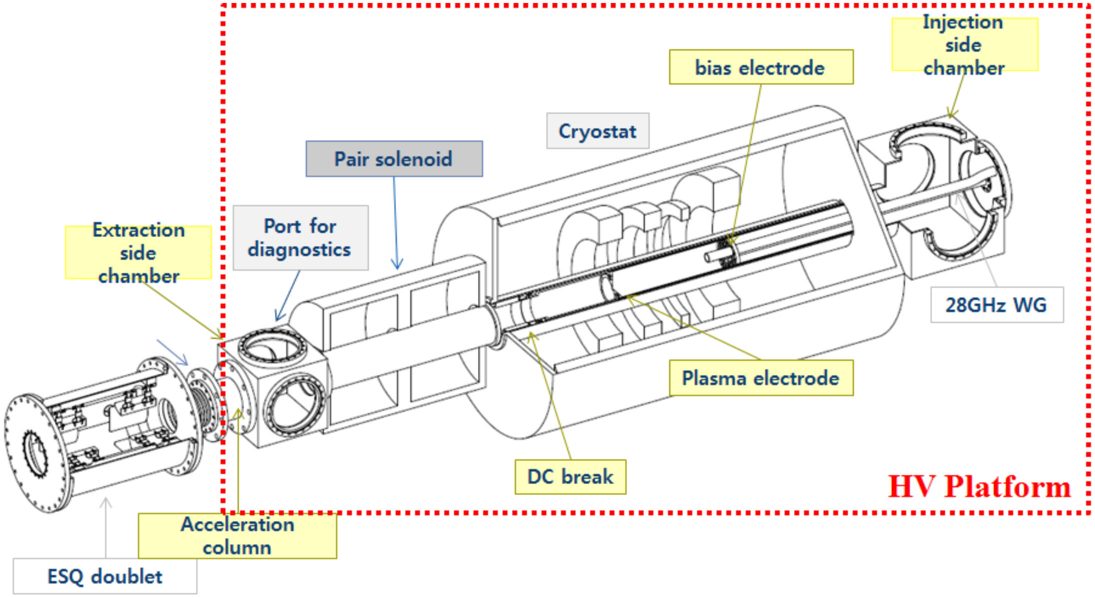
Pressed disk (13 mmΦ)

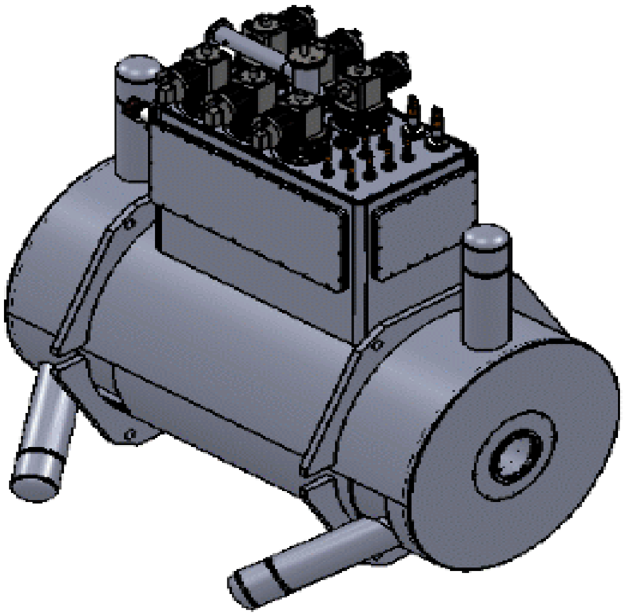
ISOL TIS/Front-End Test Facility (off-line)



Superconducting ECR Ion Source

- SC ECR IS to generate highly charged high intensity ions
- Prototype saddle type sextupole tested (2013.03-10)





RFQ design parameters

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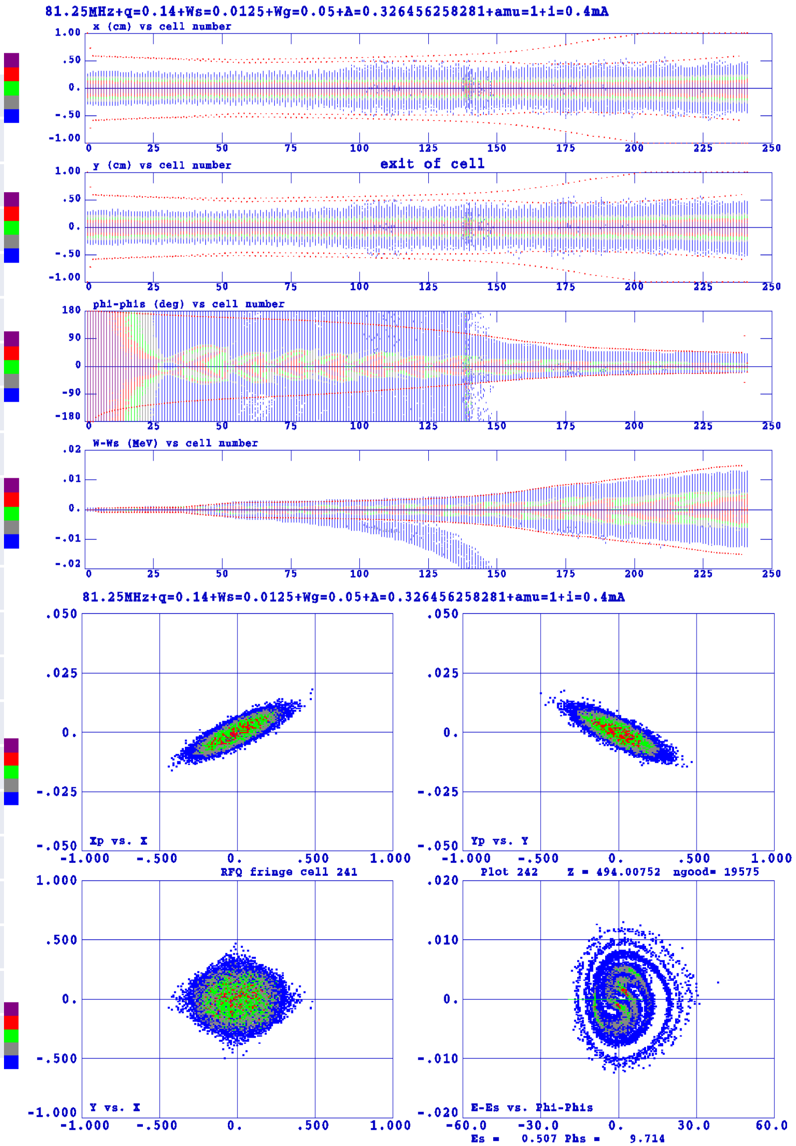
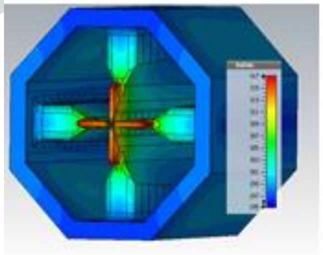
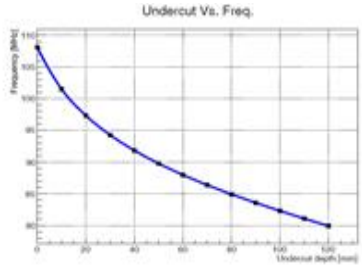
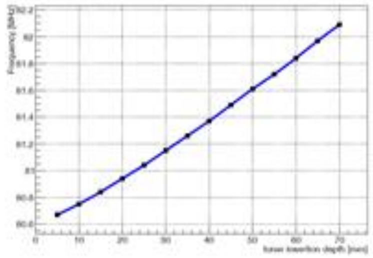
PARAMETER	VALUE
Beam Properties:	
Frequency	81.250 MHz
Particle	H^{+1} to U_{238}^{+33}
Input Energy	10 keV/u
Input Current	0.4 mA
Input Emittance: transverse (rms, norm)	0.012 .cm. mrad
Output Energy	0.507 MeV/u
Output Current for 0.4mA in.	~0.39 mA
Output Emittance: transverse (rms, norm)	0.0125 .cm. mrad
longitudinal (rms)	~26 keV/u-Degree
Transmission	~98 %
Structures and RF:	
Peak surface Field	1.70 Kilpatrick
Structure Power (for U_{238}^{+33})	92.4 kW
Beam Power (for 0.2mA each $U_{238}^{+33\&+34}$)	1.44 kW
Total Power	94 kW
Duty Factor	100%
RF Feed	1 Drive loops
Mechanical:	
Length	4.94 meter
Operating Temperature	TBD Degree C

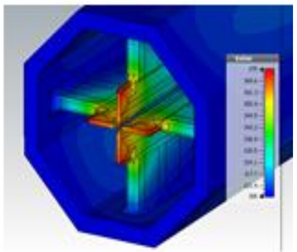


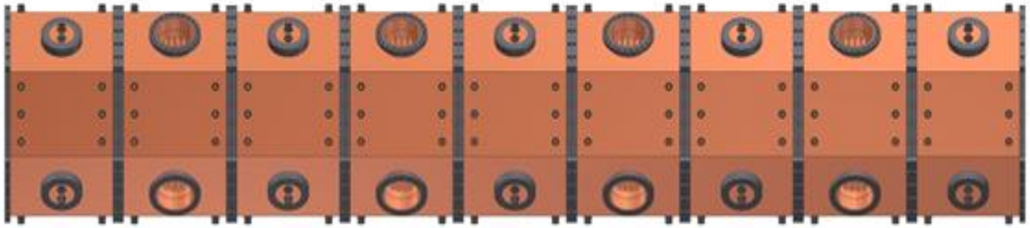
RFQ Engineering Design

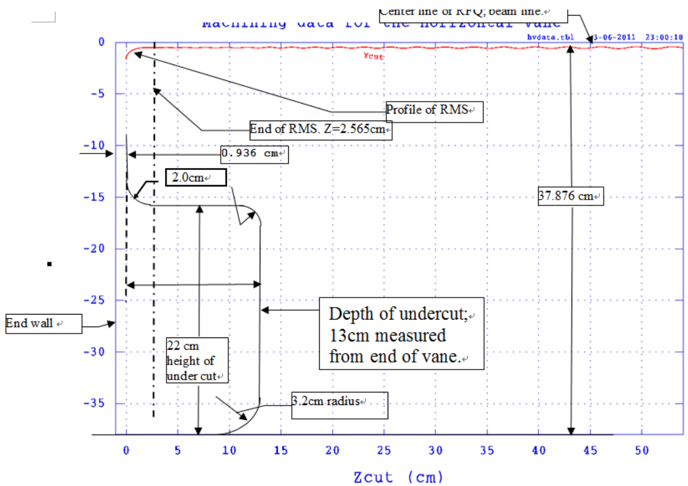




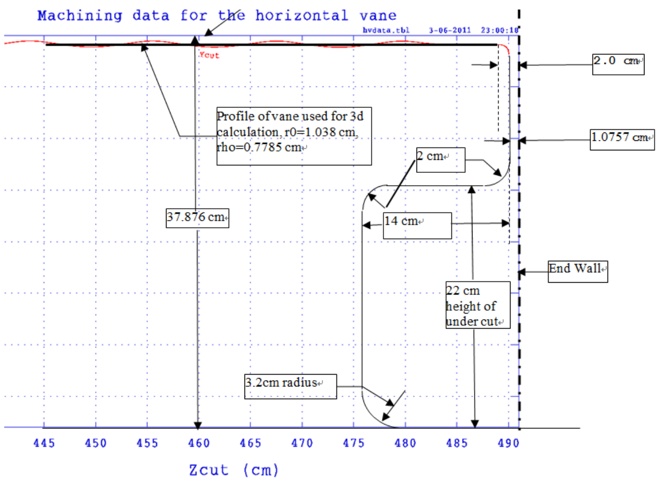








Low energy end



High energy end

Superconducting cavity

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QWR

HWR

SSR1

SSR2

Parameters	Unit	QWR	HWR	SSR1	SSR2
β_g	-	0.047	0.12	0.30	0.51
F	MHz	81.25	162.5	325	325
Aperture	mm	40	40	50	50
QR_s	Ohm	21	42	94	112
R/Q	Ohm	468	310	246	296
V_{acc}	MV	1.1	1.5	2.4	4.1
E_{peak}/E_{acc}		5.6	5.0	4.4	3.9
B_{peak}/E_{acc}		9.3	8.2	6.3	7.2
$Q_{calc}/10^9$	-	2.1	4.1	9.2	10.5
Temp.	K	2	2	2	2

(Ep = 35MV/m)

Cavity Prototyping is under way

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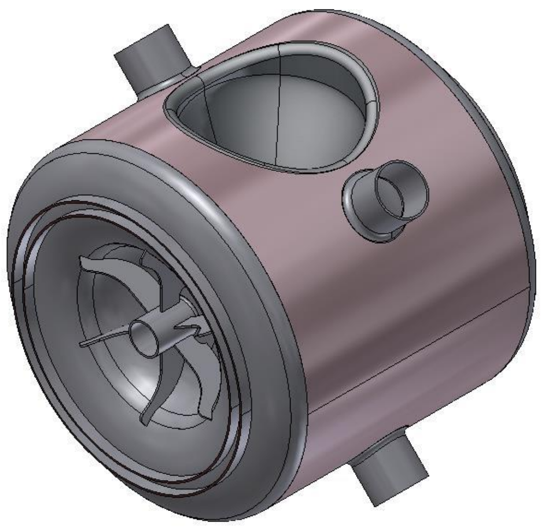
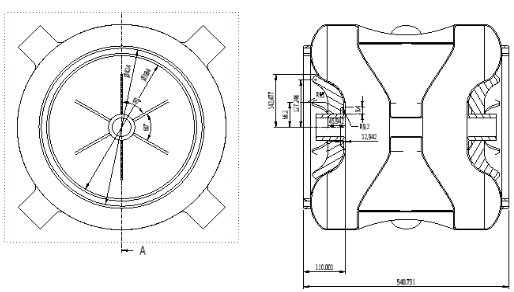
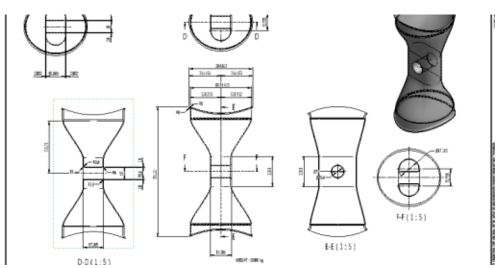


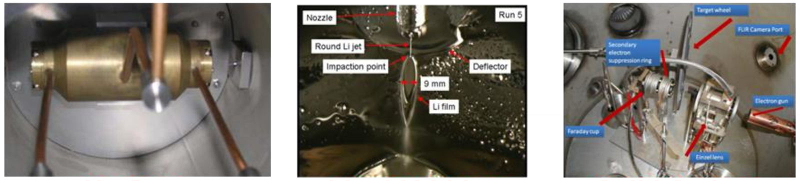




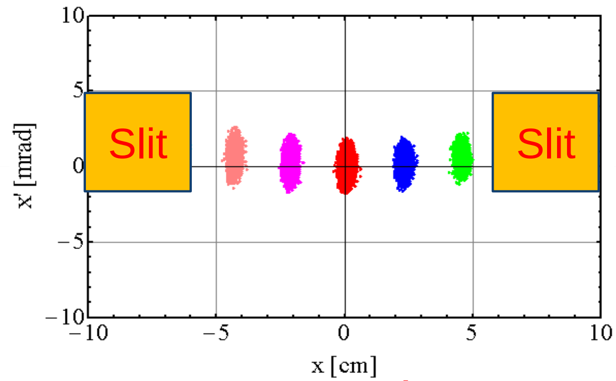
항목	진공부피 연관유무	IBS REF. DIM	IBS 소숫점첫째자리	화학세정	SFA SFA 제작(금형) 도면 DIM
Beam pass in dia(Ø)	O	50	5	0.15	49.7
Beam pass out dia(Ø)	X	55.6		0.15	55.7
Beam pass 두께	X	2.8		0.15	3
Beam pass 내경쪽 R	O	6		0.15	6.15
Beam pass 외경쪽 R	X	3.8		0.15	3.15
Beam pass welding dia(Ø)	X	67.368		0.15	63
Spoke slot width(beam length)	O	87.265	87.	0.15	87.5
Spoke slot length	O	160	16	0.15	160.3
Spoke slot center	O	72.735	72.		72.8
Spoke slot height	O	128.8	128.		128.8
Spoke pot height	O	220.75	220.		220.8
Spoke pot out dia(Ø)	O	256.625	256.	0.15	256.9
Spoke pot R	O	8		0.15	8.3
Spoke pot R(외경)	O	8			11.3
Spoke pot welding dia(Ø)	X	264.623	273.	0.15	286
Spoke beam pass welding dia(Ø)	X			0.15	63
챔버내경(Ø)	O	545.62	545.	0.15	545.3
챔버외경(Ø)	X	551.22		0.15	551.3
챔버두께	X	272.81		0.15	3
챔버폭	O	414.946	414.	0.15	414.9
챔버 Spoke pot welding dia(Ø)	X	264.623		0.15	286
챔버 진공포트 welding dia(Ø)	X			0.15	102
진공포트 내경(Ø)	O	76.9	76.	0.15	76.6
진공포트 외경(Ø)	X	(82.5)	82.	0.15	82.6
진공포트 두께	X	(2.8)	2.	0.15	3
진공포트 내경쪽 R	O	12.2	12.	0.15	12.35
진공포트 외경쪽 R	O	(15)	14.		9.35
진공포트 welding dia(Ø)	X	(106.693)	101.	0.15	102
진공포트 Length	O	345	34		345
빔포트 내경(Ø)	O	50	5	0.15	49.7
빔포트 외경(Ø)	X	(70)		0.15	55.7
빔포트 두께	X	10			3
빔포트 내경쪽 R	O	6		0.15	6.15
빔포트 외경쪽 R	X	3.8		0.15	3.15
빔포트 welding dia(Ø)	X			0.15	63
빔포트 Length	O	78.001	7		78
STIFFNESS RING 1 내경(Ø)	X	384	38	0.15	383.7
STIFFNESS RING 1 외경(Ø)	X	(396)		0.15	389.7
STIFFNESS RING 1 두께	X	6		0.15	3
STIFFNESS RING 1 폭	X	110	11	0.15	110.15
STIFFNESS RING 2 내경(Ø)	X	424	42	0.15	423.7
STIFFNESS RING 2 외경(Ø)	X	(436)		0.15	429.7
STIFFNESS RING 2 두께	X	6		0.15	3
STIFFNESS RING 2 폭	X	110	11	0.15	110.15
TOTAL LENGTH	X	540.731		0.15	541

Charge Stripper Section

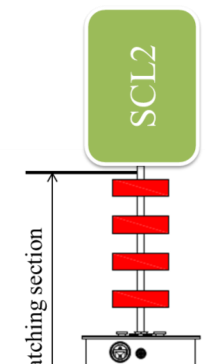
Candidate for charge stripper

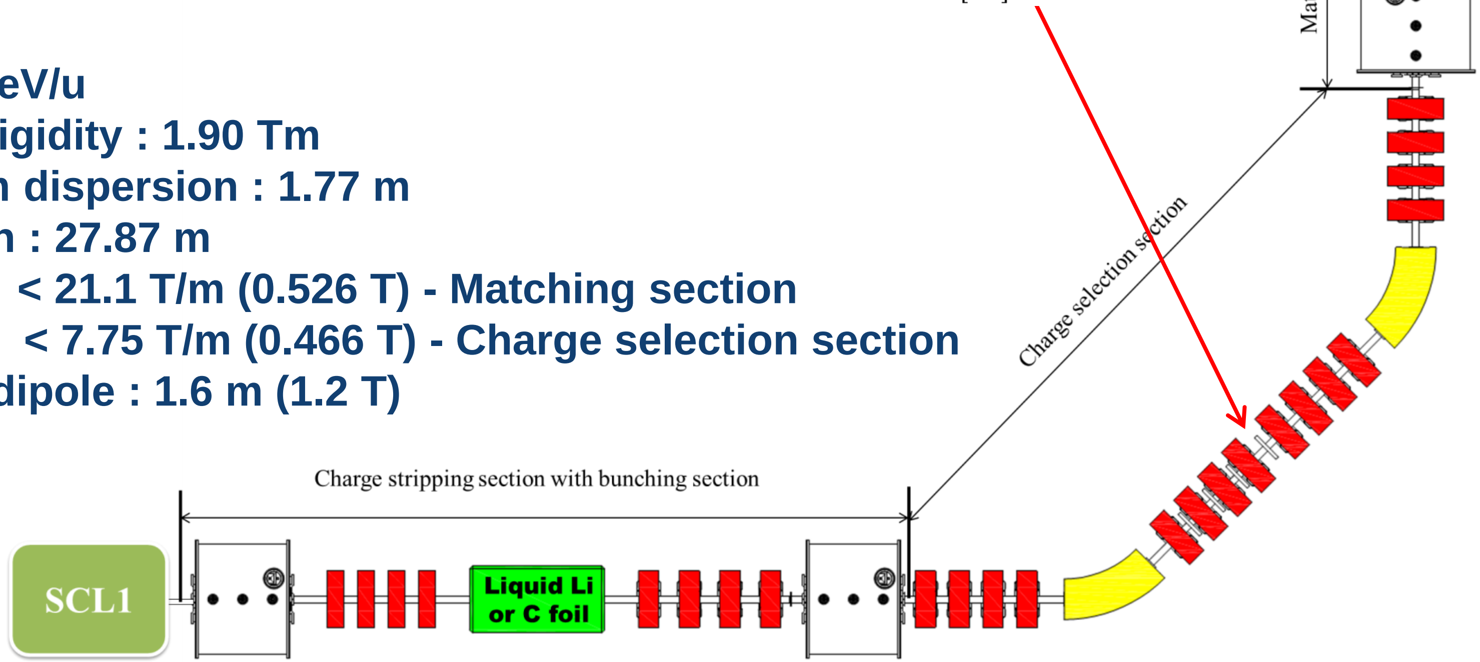


He Gas (BNL) | Liquid Lithium (ANL) | Solid Carbon (MSU)



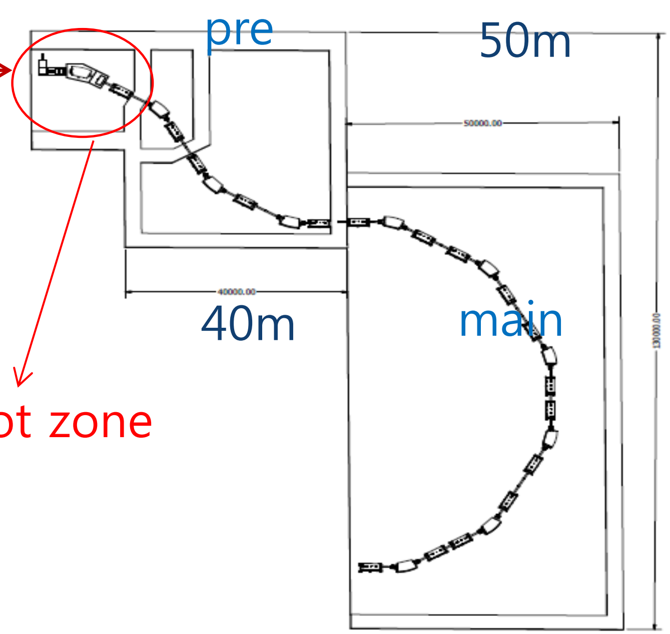
E_0 : 18.5 MeV/u
Magnetic rigidity : 1.90 Tm
Momentum dispersion : 1.77 m
Path length : 27.87 m
Str. Of QM < 21.1 T/m (0.526 T) - Matching section
< 7.75 T/m (0.466 T) - Charge selection section
Radius of dipole : 1.6 m (1.2 T)





Layout of the IF Separator

400kW,
200MeV/u
^{238}U
(8pμA)

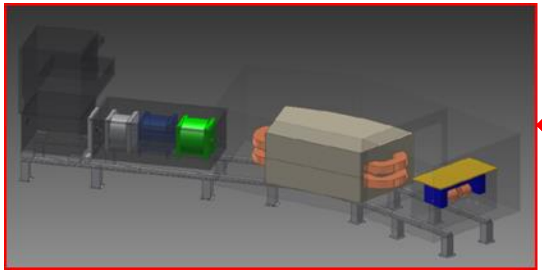


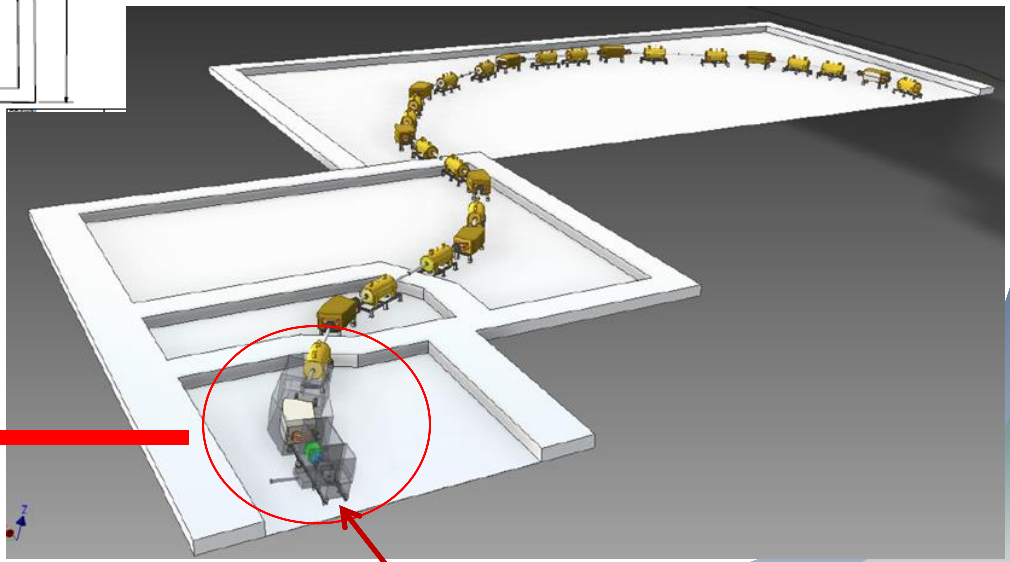
Hot zone

Separator Configuration

1. Pre-separator
   S-shape, 4 dipoles
2. Main-separator
   C-shape, 4 dipoles

Front-end of pre-separator:
Including target and beam dump





^{238}U beam

Beam optics of main separator

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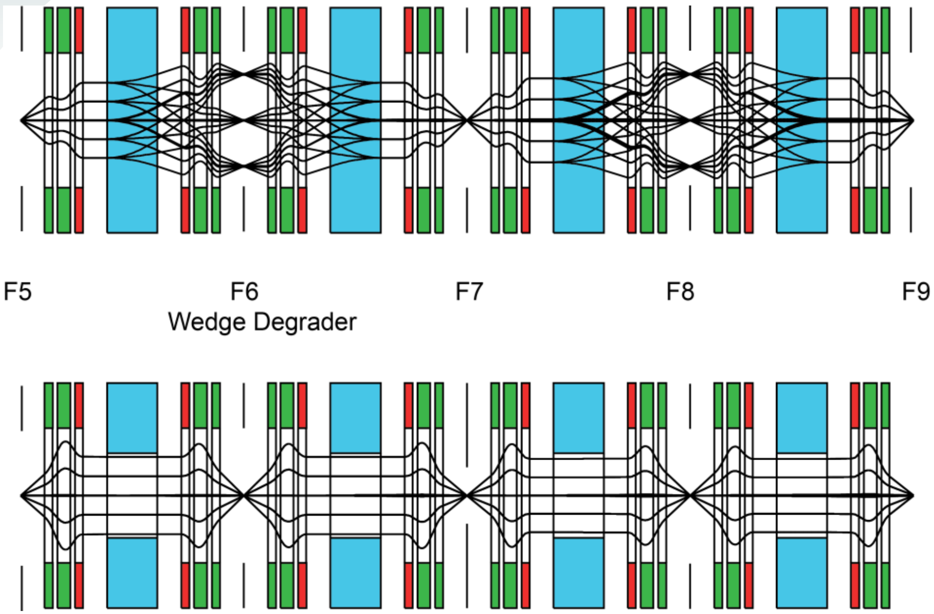
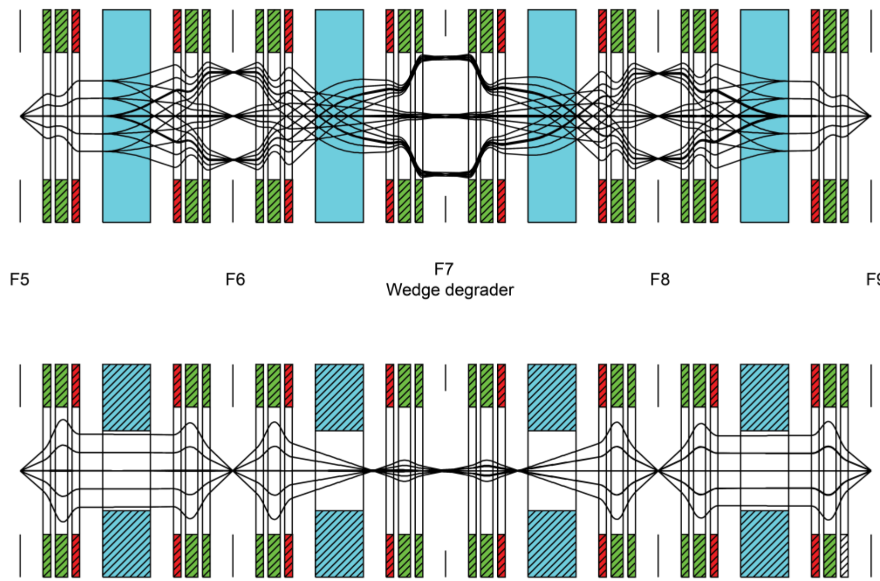
Large acceptance mode



Angular acceptance 90 mrad (h)
70 mrad (v)
Momentum acceptance ~8 %
Resolving power 2.7 cm/% at F6
2.7 cm/% at F8

High resolution mode



Angular acceptance 50 mrad (h)
50 mrad (v)
Momentum acceptance ~6 %
Resolving power 2.65 cm/% at F6
3.65 cm/% at F7
2.65 cm/% at F8

Experimental Facilities at RAON

Field	Facility	Exp. hall	Characteristics	Remark
Pure science	Recoil spectrometer – KOBRA	Low E	High resolution, Large acceptance function, RIBs production with in-flight method	Mass resolution; ~ 200 Large acceptance; ~ 80 msr
	Large acceptance Spectrometer – LAMPS(L&H)	Low & High E (I)	High efficiency for charged particle, n, and γ	TPC ; 3π sr, Neutron wall, Si-CsI array, dipole spectrometer
	High resolution Spectrometer	High E (I)	High resolution, Precise scattering measurement to the focal plan, Rotatable spectrometer	Momentum resolution ; $1.5x10^4$
	Zero-degree Spectrometer	High E (I)	Charge and mass separation, Good mass resolution	Momentum resolution ; 1200~ 4100
	High precession mass measurement system	Ultra low E	Penning trap, Multi-reflection Time of flight	Mass resolution ; 10^{-5}~ 10^{-8}
	Collinear laser Spectroscopy	Ultra low E	High Resolution Laser Spectroscopy System	Spectral resolution ; $\leq$ 100 MHz
Applied science	β-NMR/μ-SR	Low / High E (II)	High intensity ^{8}Li & muon production	^{8}Li & muon > 10^8 pps
	Bio-medical facility	Low & High E (II)	Irradiation system for stable & radio ion beam	Uniformity ; < 5%
	Neutron science Facility	Low E	Fast neutron generation & measurement system of fission cross section	Uncertainty ; < a few %

Collaboration

RAON

Domestic collaboration

Institute

KAERI/KOMAC/NFC, KINS, KRISS

University

Seoul Nat'l U., Chung-Ang U., Hoeso U., Sungkyunkwan U., Pusan Nat' U., Korea U., Chonbuk Nat' U., Kookmin U., Kyungpook Nat' U., Catholic U., Inha U., Chungbuk U., Hanyang U.

Industry

KeumRyong Tech, HMT Co.

Summary

- RISP is a challenging project in this field, and as a newcomer we are practically crossing the technical design stage.
- The R&D of ISOL target chemistry is on-going from July this year, and ion sources are in the making one by one.
- The off-line test facility of the TIS front-end system is at the final engineering design stage.
- Extensive & active collaboration with advanced foreign institutes seems to be essential, in particular, for the successful development of RF-cooler, HRMS, charge breeder and A/q separator.
- The first exotic beam from ISOL at RISP is expected hopefully in early 2019.

Thank you for attention !

- **Acknowledgements**

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